Phonon Drag in InSb: Theory and “spin”-motive force STEWART BARNES, Department of Physics, University of Miami, Coral Gables, FL 33124, JOSEPH HEREMANS, Department of Mechanical and Aerospace Engineering, and Department of Physics, The Ohio State University, Columbus, OH 43210, — The phonon number operator $\hat{n} \rightarrow \sin^2 \frac{\theta}{2}$ defines the Euler angle $\theta$ and with the phase $\phi$ this maps to a precessing spin. Defined are a “spin” Berry phase and a “spin”-motive force (smf)\textsuperscript{[1]}. Unlike an emf, an smf can act upon neutral phonons. Tradition\textsuperscript{[2]} has sub-thermal phonons as central to the thermopower of semi-conductors. The momentum given to these phonons, by the temperature gradient, is transferred to the electrons by “drag” where it cancels a Seebeck effect electric field $\vec{E}$. Here, for InSb at low temperatures, thermal phonons actually relax momentum via boundary and umklapp scattering and energy conservation involves sub-thermal phonons, created by anharmonic effects, with a frequency $\hbar \omega_{\vec{q}} \sim k_B (dT/dx) \ell$ where $\ell$ is the phonon mean-free-path (mfp). The resulting smf acting upon the thermal phonons produces a “spin” voltage $\sim (k_B/e) \Delta T \sim 100 \mu$V/K. Via the electron-phonon interaction, the smf, multiplied by the ratio $\ell_{ep}/\ell$, where $\ell_{ep}$ is the electron-phonon mfp, are detected, but not created by the few electrons in our InSb samples. \textsuperscript{[1]} S. E. Barnes and S. Maekawa, Phys. Rev. Lett. \textbf{98}, 246601 (2007) \textsuperscript{[2]} C. Herring, Phys. Rev. \textbf{95}, 954 (1954).

Stewart Barnes
Physics Dept., Univ. of Miami, Coral Gables FL

Date submitted: 09 Nov 2012

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